DRAINAGE MASTER PLAN
AND
NEEDS ASSESSMENT

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ESCAFCA
Eastern Sandoval County Arroyo Flood Control Authority

JUNE 27, 2008

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MAY 13, 2008

I, Daniel S. Aguirre, do hereby certify that this report was prepared by me or under my direction and that I am a duly registered Professional Engineer under the laws of the State of New Mexico.

Daniel S. Aguirre, P.E.
NMPE #11955

6/30/08
Date

Abstract

As a newly-chartered government agency created to establish and maintain a flood control system for the benefit of its constituents, the Eastern Sandoval County Arroyo Flood Control Authority (ESCAFCA) must assess drainage issues facing the Authority and determine an appropriate course of action to efficiently accomplish this goal. The purpose of this paper is to present the results of a jurisdiction-wide assessment of watershed runoff and to establish a project schedule for the 2009 fiscal year. This analysis incorporates Arid Land Hydrologic Modeling (AHYMO) analysis of the watershed, hydraulic analysis of strategic and other major structures, and order-of-magnitude cost estimates of potential improvements to develop a comprehensive plan for effective storm water management within ESCAFCA's jurisdiction. This paper reports peak flows and flow capacities for key points and structures in the watershed, provides an estimate for levels-of-effort required to bring each basin to acceptable minimum design standards, establishes a schedule and order-of-magnitude cost estimates for FY 2009 projects, and recommends a strategy to facilitate public involvement for ESCAFCA constituents. This report is useful to engineers and technically proficient individuals as a reference both for initial drainage conditions within ESCAFCA jurisdictional boundaries and also for planned ESCAFCA projects and improvements in the near term.

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1 Introduction

It is an accepted tenet of hydrology that, in general, urbanization increases both the volume and peak discharge of storm water runoff. Inasmuch as urbanization changes a region's hydrology, prudence dictates that populated areas take positive action to ensure that development does not outpace an infrastructure's capacity to safely control runoff. Often, a government agency is created to adopt policy pertaining to the disposition of storm and flood waters, to administer and enforce the various orders and directives it has adopted, and if necessary, to provide for the design and construction of drainage infrastructure.

For the purpose of this study, the following definitions have been adopted:
I. Watershed—A watershed refers to the topographic area that collects and discharges storm water runoff to a single outlet. The outlet of the ESCAFCA watershed is the lowest point on the Rio Grande in the southwest corner of the jurisdiction. It should be noted that the ESCAFCA watershed contains areas that lie outside of its jurisdictional boundaries.
II. Drainage Basin—A drainage basin (or just "basin") will be understood to refer to a constituent topographic area within the ESCAFCA watershed whose main flow path is a named waterway or drainage facility. (E.g., the Arroyo Maria Chavéz basin or the Agua Sarca basin)
III. Sub-basin—A sub-basin refers to the smallest constituent topographic area within a watershed or drainage basin. Sub-basins in this study have been limited in most cases to less than 1 square mile in area.
IV. Study Unit—A study unit refers to an area of the ESCAFCA jurisdiction which has been divided based on an administrative basis. A study unit's boundary is delineated on a variety of factors (geography, accessibility, data availability, etc.) and is not necessarily coincident with a basin boundary.

1.1 Authority

The Eastern Sandoval County Arroyo Flood Control Authority (ESCAFCA) is a political subdivision of the State of New Mexico, created in ***HB 939 Eastern Sandoval County Arroyo Flood Control Authority Act*** [§72-20-01 through §72-20-103, NMSA 1978] during the 2007 Legislative session. ESCAFCA's purpose is to acquire, equip, maintain and operate a flood control system for the benefit of the authority and the inhabitants of Eastern Sandoval County. ESCAFCA's duties are governed by a Board of five directors. Per the §72-20-08 of the Act, "the exercise of any executive, administrative and ministerial powers may be, by the board, delegated and redelegated to officers and employees of the authority or to any officer or employee contracted by agreement to manage and administer the operations of the authority."

Whereas the State of New Mexico has imposed upon ESCAFCA the duty and authority to administer drainage policy, Wilson & Company has been authorized to produce this Watershed Management Plan on its behalf.

1.2 Purpose

The purpose of this report is to present an overview of storm water runoff within ESCAFCA jurisdictional boundaries. The report provides an accurate qualitative and quantitative characterization of the jurisdiction's runoff potential so that the Board can make informed decisions regarding flood control and storm water management. A comprehensive storm water management plan is a useful tool in accomplishing this result.

1.3 Goals and Objectives

The objectives of this report are to:

a. Establish catchment boundaries and manageable study units for areas directly affecting ESCAFCA jurisdiction,
b. Compute hydrologic analysis (both existing and future conditions) for a 24-hr, 100-yr design rainfall event using AHYMO software,
c. Identify a program for construction of drainage mitigation solutions within the ESCAFCA jurisdictional boundary,
d. Identify existing and potential future drainage outfalls to the Rio Grande,
e. Produce "level of effort" estimate to develop a master drainage plan and suggest a methodology for developing a study priority scheme,
f. Identify any urgently needed projects and right-of-way (ROW) acquisitions,
g. Produce a bibliography of all pertinent reports and plans affecting watersheds within ESCAFCA jurisdictional boundaries, and
h. Recommend a strategy for public involvement in ESCAFCA

2 Existing Conditions

2.1 Watershed Description

The ESCAFCA watershed is comprised of several ephemeral streams that historically discharged to the Rio Grande. The largest streams originate in the Sandia Mountains, while several smaller arroyos and watercourses originate in the Sandia foothills. With the exception of the Piedra Liza Arroyo, in which flow is attenuated with a flood control dam, all streams and arroyos discharge freely to culverts at I-25. In general, development downstream and west of I-25 culverts has cut-off or filled-in historic drainage paths to the Rio Grande. As a result, storm water runoff is conveyed in shallow swales that are undersized for larger storm events, and along road, railway, or irrigation embankments to low-lying areas. At these low points, water settles and continues to pond until it crests whatever structure (most commonly, an embankment) is retaining it. At certain locations during less-frequent rainfall events, runoff overtops embankments of MRGCD irrigation ditches and is conveyed back to the Rio Grande. Occasionally, this results in surcharge or even breaching of MRGCD ditches. Las Huertas Creek is the largest drainage basin in the ESCAFCA watershed. Las Huertas Creek and Arroyo Maria Chavéz are the only two basins that discharge to the Rio Grande in an established, well-defined watercourse.

The upper watershed is characterized by undeveloped, heavily vegetated forest with very steep (30-50%) slopes, and considerable areas of rock outcropping with sheer cliffs (50-70% slopes). The middle watershed exhibits milder slopes (10-30%) with vegetation

typical of alluvial fan environment. The majority of the middle watershed is approximately 70% undeveloped, with the remaining 30% exhibiting low-density (0.67 DU/acre) residential development. The lower watershed is characterized by relatively flat (0-10%) slopes with a variety of development, ranging from semi-rural and agricultural, to residential (1-2 DU/acre), to commercial land usage.

2.2 ESCAFCA Boundaries

ESCAFCA boundaries are defined in §72-20-06 NMSA, 1978 with limits, generally, at

V. the northern border of township 13 north of the New Mexico principal meridian,
VI. the (projected) eastern border of range 5 east of the New Mexico principal meridian,
VII. the west bank of the Rio Grande, and
VIII. the southern border of township 12 north of the New Mexico principal meridian

As these boundaries are exclusive of federal and tribal lands and pueblos, ESCAFCA's jurisdiction is essentially divided into northern and southern areas.. Approximate ESCAFCA boundaries are shown below in Figure 1. It should be noted that the boundaries described in this report represent the most accurate data available from the Sandoval County GIS department and the New Mexico Resource Geographic Information System Program (RGIS). A formal boundary survey would be required to determine the exact limits of ESCAFCA jurisdiction.

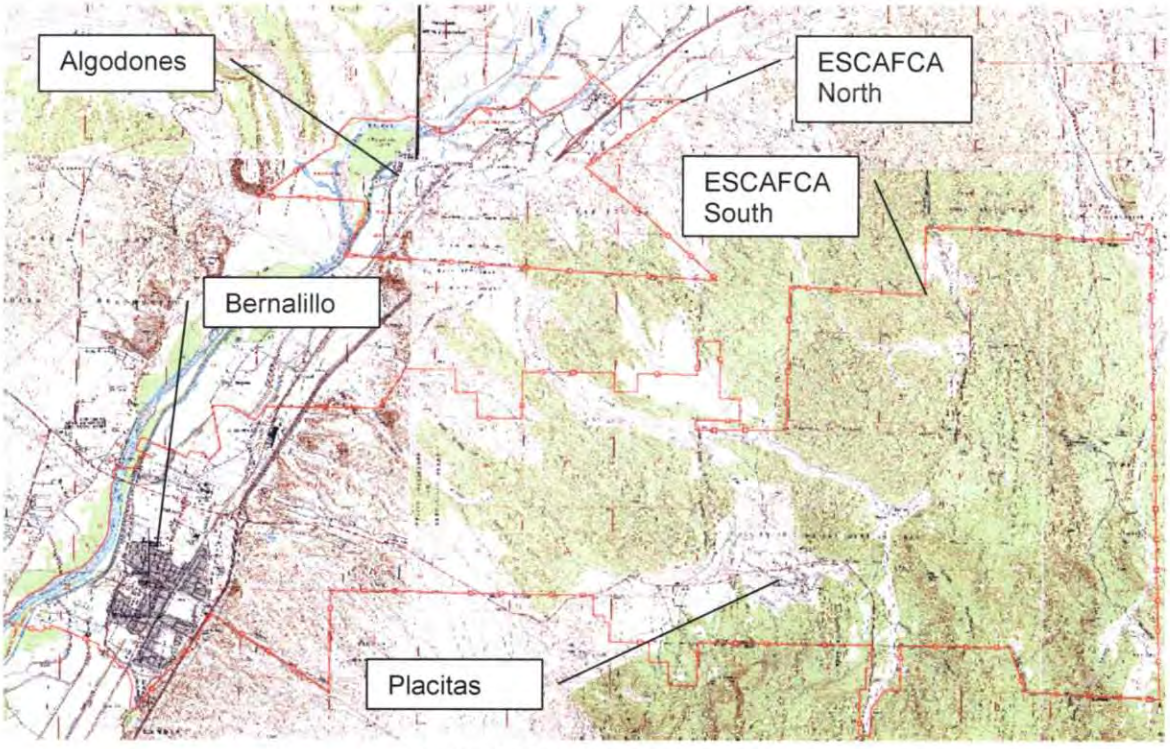

Figure 1: ESCAFCA Boundaries

The north portion of the jurisdiction is approximately 6.1 mi^2 and the south portion of the jurisdiction is 39.1 mi^2. The total area analyzed, including offsite sub-basins, is approximately 64.2 mi^2.

2.3 Existing Improvements

An inventory of major existing drainage structures and improvements within ESCAFCA was conducted for this study. The following structures and improvements will, to some extent, dictate management of the watershed.

2.3.1 Piedra Liza Dam (Natural Resource Conservation Service)

The Piedra Lisa Dam is a 144 ac-ft flood control structure southeast of the intersection of Interstate 25 and NM 165. This structure was completed in 1955 and experienced major renovation to its emergency spillway in 2007.

While the Piedra Liza Dam provides considerable protection to the Town of Bernalillo during major rainfall events, discharge from the dam during more frequent events creates nuisance flows, ponding, and occasional flooding since no defined waterways exist to convey runoff through the town to the Rio Grande.

2.3.2 Interstate 25 Drainage System and Crossing Structures

Wilson & Company has inventoried and catalogued drainage crossing structures along the I-25 corridor both through field reconnaissance and existing documentation. It has been determined that the structures themselves are adequate to convey existing and future flows, however due to lack of maintenance some of the structures are obstructed by debris and sediment.

2.3.3 NM 165 Crossing Structures

Wilson & Company has inventoried and catalogued drainage crossing structures along the NM 165 corridor both through field reconnaissance and existing documentation. It has been determined that the structures themselves are adequate to convey existing and future flows, however some of the structures have been obstructed by debris and sediment.

2.3.4 Major Drainage Ways and Conveyance Structures

2.3.4.1 Rio Grande

The Rio Grande is the exit point for all drainage basins within ESCAFCA jurisdiction. The Bureau of Reclamation manages the Rio Grande and administrates all improvements discharging into it. As stated previously, only Las Huertas Creek and Arroyo Maria Chavéz discharge directly to the Rio Grande. With these two exceptions, the east bank of the Rio Grande is disconnected from the basins to the east both by levees and by the MRGCD Albuquerque Wasteway embankment. These structures block runoff and prevent storm water from discharging to Rio Grande.

2.3.4.2 Las Huertas Creek

Las Huertas Creek is the largest drainage basin within ESCAFCA's jurisdiction and extends from the crest of Sandia Peak, through the Placitas area, and to the Rio Grande just south of Algodones. Las Huertas Creek is one of two major watersheds with a defined outlet to the Rio Grande. With the exception of crossing structures (discussed below), the majority of the watercourse is unimpeded by development, allowing flows to meander naturally within the floodplain. In the middle reach of the Las Huertas basin,

between the USFS boundary and Camino de Las Huertas, some development appears to be located within the 100-year floodplain. Downstream of NM 313, levees have been constructed which channelize Las Huertas Creek. These structures appear to be undesigned and pose a severe threat to adjacent residences and farmland.

Major crossing structures of Las Huertas Creek are located at Camino de Tecolote, Camino de la Rosa Castilla, Camino de Las Huertas, Interstate 25, BNSF railway, NM 313, and the Albuquerque Main Canal. Although most crossing structures appear to have adequate capacity to convey flows, several structures (specifically, Camino de Tecolote and Camino de Las Huertas) appear to need embankment protection to pass flows without endangering the roadway. Inadequate embankment protection was probably the leading contributing factor in a washout of the Camino de Las Huertas crossing, which occurred during and monsoon rainfall event in the summer of 2006.

2.3.4.3 Arroyo Maria Chavéz

Arroyo Maria Chavéz is a major drainage basin within ESCAFCA's jurisdiction and is one of only two major watersheds with a defined outlet to the Rio Grande. The outfall is located just north of Algodones within Santa Ana Pueblo lands. A recent study has been completed by the NMDOT for replacement of the NM 313 Bridge.

2.3.4.4 Arroyo de San Francisco

This arroyo is located near the most northern boundary of ESCAFCA's jurisdiction. However, the watershed lies entirely within US Forest Services lands and discharges into San Felipe Pueblo lands. This arroyo was not included in this study because it does not directly impact lands under ESCAFCA jurisdiction.

2.3.4.5 Middle Rio Grande Conservancy District (MRGCD) Infrastructure

The MRGCD maintains an extensive network of acequias, canals, and laterals within the ESCAFCA jurisdiction. From approximately March 1 to September 30 annually, these structures deliver water diverted from the Rio Grande to farm lands for irrigation. In general these structures act as levees to surface drainage, directing runoff downstream along MRGCD embankments. Siphons, roadway crossings, and other breaks in MRGCD embankments allow storm water to cross MRGCD infrastructure. MRGCD canals are not designed to convey storm water runoff, and excessive velocities along embankments can result in breaching or other damage to MRGCD infrastructure. Major structures affecting drainage within ESCAFCA jurisdiction include:

- Albuquerque Riverside Drain
- Algodones Riverside Drain
- Bernalillo Interior Drain
- Bernalillo Riverside Drain
- Ranchitos Drain
- San Felipe Riverside Drain
- Albuquerque Main Canal
- Algodones Acequia
- Bernalillo Acequia
- Sandia Acequia
- Algodones Lateral
- Bosque Lateral #1 & #2
- Santa Ana Lateral
- Yeso Lateral
- Santa Ana Wasteway

2.4 Documented Drainage Problems

2.4.1 Algodones

Of the communities served by ESCAFCA, the Town of Algodones reports the fewest drainage problems, with three documented incidents. Most of the reported incidents characterize drainage issues as frequent and severe, with almost every rainfall event resulting in considerable damage. Algodones residents have reported the following drainage problems:

- Flooding with damage
- Breaching or overtopping of MRGCD canals

Drainage problems in Algodones can generally be attributed to development within historic drainage paths which prevents adequate conveyance of storm water runoff to the Rio Grande. This is exacerbated by generally flat grades throughout Algodones. See Exhibit A.1, Algodones Area Deficiencies, in Appendix A for locations of drainage problems in Algodones.

2.4.2 Bernalillo

Of the communities served by ESCAFCA, the Town of Bernalillo reports the most drainage problems, with 25 documented incidents. Most of the reported incidents characterize drainage issues as frequent, with almost every rainfall event resulting in some degree of damage or inconvenience. Bernalillo residents have reported the following drainage problems:

- Nuisance flows / ponding
- Flooding with damage
- Breaching or overtopping of MRGCD canals
- Breaching or overtopping of detention ponds

The alignment of NM 550 follows a relative high point dividing the Town of Bernalillo. The Town of Bernalillo receives storm water runoff from an offsite drainage area of approximately 16.5 mi^2, 4.1 mi^2 of which is controlled by the Piedra Liza Dam. Offsite flows from the Sandia Mountains and foothills discharge to the Town through a system of NMDOT culverts. Drainage problems in Bernalillo can generally be attributed to development within historic drainage paths which prevents adequate conveyance of storm water runoff to the Rio Grande. Drainage problems are exacerbated by flat grades throughout Bernalillo.

2.4.2.1 South of NM 550

Offsite areas of approximately 10.5 mi^2 discharge to Bernalillo south of NM 550. Drainage in the southern portion of Bernalillo runs generally northeast to southwest. Downstream of I-25, runoff is conveyed in shallow, undersized swales to the South Hill Road embankment which directs runoff to the south. As runoff depths increase, South Hill Road is overtopped and runoff ponds against the Bernalillo Acequia embankment, continuing flow to the south. Excessive ponding against the MRGCD embankment is relieved by overtopping at roadway crossing siphons or at localized breaches of the acequia. This pattern of ponding and overtopping is repeated along north-south embankments, notably the BNSF railway, the Bernalillo Interior Drain, and the Bernalillo Riverside Drain. Several roads, including Camino del Pueblo and Camino Don Tomas, tend to trap runoff in sag vertical curves. Low lying areas within the town are prone to extended periods of standing water, especially those locations where infiltration is impeded by a high water table.

The majority of drainage problems in Bernalillo south of NM 550 occur between the BNSF railway and I-25. See Exhibit A.2, South Bernalillo Area Deficiencies, in Appendix A for specific locations of drainage problems in southern Bernalillo.

2.4.2.2 North of NM 550

Offsite areas of approximately 5.7 mi^2 discharge to Bernalillo north of NM 550. Drainage in the northern portion of Bernalillo is generally east to west. Drainage is similar to that of southern Bernalillo, with runoff ponding against MRGCD, road, and railway embankments. As ponding depths increase, runoff eventually overtops these embankments at relative low spots in these alignments. As stated previously, fewer drainage inadequacies are documented north of NM 550, however, it should be noted that development in this area is considerably less dense than south of NM 550. Further development in the area will result in both increased runoff and decreased area for unimpeded surface flow (i.e., through vacant lots or farm land). These factors would contribute to risk of future drainage problems.

The majority of drainage problems in Bernalillo north of NM 550 occur in a corridor bounded on the north by Calle Valle Serrano and on the south by Old Highway 44. Bernalillo High School and Days Inn have both documented inadequate drainage. See Exhibit A.3, North Bernalillo Area Deficiencies, in Appendix A for specific locations of drainage problems in northern Bernalillo.

2.4.3 Placitas

The Village of Placitas reports several drainage problems, with 11 documented incidents. Most of the reported incidents are characterized as infrequent, with the majority of problems resulting from more severe rainfall events. Placitas residents have reported the following drainage problems:

- Overtopping and roadway wash-outs resulting from undersized culverts
- Flooding with damage
- Erosion of arroyos resulting in damage to roadway embankments and exposure of natural gas pipelines

Drainage issues in Placitas are typically characterized by erosion problems and blocked or undersized crossing structures. These issues can generally be attributed to inadequate maintenance or failure to design or construct structures within existing arroyos to appropriate standards. See Exhibit A.4, Placitas Area Deficiencies, in Appendix A for locations of drainage problems in Placitas.

3 Hydrologic Analysis

3.1 Design Considerations & Assumptions

The following considerations and assumptions have been made to facilitate this study:

- AHYMO land treatments have been determined based on the procedures established in the City of Albuquerque Development Process Manual (DPM). BLM, Forest Service, and Indian Lands are assumed to remain undeveloped in both existing and future models. Other incorporated areas are assumed developed based on historical DU/acre ratios.
- Sandoval County Development Division's ***2007 Annual Report*** was consulted in the preparation of this report. To ensure the most conservative flow estimates, the future conditions model assumes development in all areas where development is possible.
- The future conditions model assumes existing flow patterns and no drainage improvements.

3.2 Methodology

Hydrologic analysis of the watershed was completed using the Arid Lands Hydrologic Model (AHYMO) software. AHYMO computes a hydrograph for each sub-basin based on its physical properties. These hydrographs are then routed along waterways and drainage paths to determine a peak discharge at areas of interest throughout the watershed.

3.3 Basin Characteristics

Basin characteristics such as area, land treatment (i.e., hydrologic soil group), infiltration rate, and lag time are used as input to AHYMO. These variables and their development are described below.

3.3.1 Basin Areas

The drainage basin areas defined in this study have been delineated using Sandoval County aerial survey with 10-ft contours and supplemented by USGS 7½ minute quadrangle mapping. Where available and/or applicable, detailed studies (listed in the bibliography) have been used to provide more specific basin information. Where feasible, sub-basin areas were limited to a maximum of one square mile to better ensure homogenous properties throughout the sub-basin, thus providing a more accurate description of runoff potential. Drainage area boundaries are shown in Plate I at the end of this report.

3.3.2 Land Treatment and Infiltration

In AHYMO, land treatment refers to the classification of a sub-basin's soils based on type, use, vegetation, and slope. Each of these parameters affects a sub-basin's runoff potential. In this model, each sub-basin is characterized by four land treatments (A through D) as a percentage of the sub-basin's total area. It should be noted that, although somewhat analogous to the NRCS Soil Hydrologic Group methodology, land treatments are not the same, despite having the same A—D nomenclature. AHYMO uses this input to calculate a weighted-average infiltration rate for the sub-basin, which is then used to generate a representative unit hydrograph.

Infiltration used in the AHYMO model assumes an initial abstraction followed by a constant infiltration rate for the duration of the storm. A weighted average initial loss and infiltration rate was used for each basin for AHYMO computation. Initial loss values and infiltration rates have been developed in Reference 4 for the Albuquerque metropolitan area based on land characteristics and usage. Infiltration characteristics for this report were developed through field reconnaissance and review of NRCS soil survey. Overall initial abstraction values and infiltration rates are area-weighted averages of overall basin characteristics. The following is a summary of infiltration rates and soil conditions:

Land Treatment	Initial Abstraction (in)	Infiltration Rate (in/hr)	Land Description
A	0.65	1.67	Soil uncompacted by human activity with 0 to 10% slopes. Native grasses, weeds and shrubs in typicall dentsities with minimal distrubance
B	0.5	1.25	Irrigated lawns, parks, and golf courses with 0 to 10% slopes. Native grasses, weeds and shrubs, and soil uncompacted by human activity with slopes greater than 10% and less than 20%.
C	0.35	0.83	Soil compacted by human activity. Minimal vegetation. Unpaved parking, roads, trails. Most vacant lots. Native grass, weed and shrub areas with clay or clay loam soils and other soils of very low permeability as classified by SCS Hydrologic Soil Group D.
D	0.1	0.04*	Impervious areas, pavement and roofs. *Applicable from 0 to 3 hrs, then decreasing linearly to no infiltration at 6 hrs.

Table 3.1: Infiltration & Soil Group

For the Existing Conditions model, east of I-25, the following general land treatment assumptions were made:

- 65% - Land Treatment A
- 15% - Land Treatment B
- 15% - Land Treatment C, and
- 5% - Land Treatment D

However, it should be noted that percentages were adjusted to account for steep slopes at eastern areas of the watersheds. Under Proposed Conditions, undeveloped areas, with potential for future development, were assigned a ratio of dwelling units per acre that corresponded with existing ratios in the vicinity. Land treatment percentages for these basins were then calculated per the City of Albuquerque DPM.

3.3.3 Time of Concentration

Time of concentration (t_c), refers to the amount of time required for a sub-basin to generate its peak discharge. AHYMO uses the Lag Time methodology to compute time of concentration. This method uses a sub-basin's length, slope (adjusted for steepness), Manning's 'n', and shape to determine t_c.

3.3.4 Routing

This model uses the Muskingum-Cunge procedure to route hydrographs through a channel reach. This procedure uses quantifiable physical properties (length, cross-sectional area, Manning's 'n', etc.) to determine the degree to which a channel reach attenuates peak flow. For this report, routing through existing dam structures was based on design analysis reports and construction plans of the existing structures. AHYMO is capable of using a manually-input hydrograph and inserting it into the model such that the model reflects the precise design of a given structure. Where Muskingum-Cunge "c" coefficient computation methods differed from the existing to future models, time increments were adjusted in order to capture the most conservative peak discharges. These adjustments were most common in sub-basins with very steep slopes. It should

be noted that these models were used to quantify peak flow rates and should be further investigated in the analysis of peak discharge volumes.

4 Planning and Watershed Management

4.1 Study Units

Addressing the issues in a jurisdiction of ESCAFCA's size requires a systematic and logical analysis process to ensure that any proposed course of action is both fiscally possible and beneficial to inhabitants. To do so, the jurisdiction has been divided into study units (defined on page 1). The logical course of action is to rank each study unit by priority and level-of-effort to construct the required improvements within the study unit. It can be generalized that "priority" refers to a ranking based on need for improvement, and "level of effort" refers to a ranking based on the ability to provide improvement (in terms of budget/fiscal obligation). The ESCAFCA jurisdiction has been divided into the following study units:

1. Algodones
2. Bernalillo – South
3. Bernalillo – South
4. Arroyo Maria Chavéz
5. Las Huertas Creek – Lower
6. Las Huertas Creek – Upper
7. Arroyo Agua Sarca
8. NM 165
9. Canon del Agua
10. Arroyo de San Francisco

Study units have been delineated based on a variety of factors, including common land usage, common outfall location, and common political boundary. Study units have been named based on the most prominent feature within the study unit. See Exhibit B.1, Overall Drainage Basins, (Appendix B) for a reference map of study units.

4.2 Priority

Several factors should be considered when establishing priority for improvements. In general, priority should be given to a study unit for which need has been demonstrated, and improvements can provide benefit. In order of importance, the established priority criteria are:

1. Documented flooding of existing development with significant damage or injury
2. Documented flooding of existing development with minimal damage or injury
3. Potential flooding of an area where development is either imminent or current
4. Potential flooding of an area where planning of development is imminent or current
5. Potential flooding of an area where future development is likely but not imminent
6. Large quantity of existing or readily-available data
7. Possibility of joint funding for study or construction projects

4.3 Level of Effort

"Level of effort" is an estimate of the work required to analyze a particular area among a group of areas. To effectively plan improvements, it is important to have an understanding of the difficulties involved. A "level of effort" matrix is an effective way to rank the relative costs inherent in analyzing study units and designing solutions for any drainage deficiencies. Factors included in this level of effort estimate are:

1. Contributing Area
2. Hydrologic Complexity
3. Current State of Development
4. Availability of Suitable Outfall
5. Jurisdictional Complexity
6. Availability of Data

A description of each factor is described below.

4.3.1 Contributing Area

Level of effort is almost always directly related to the size of the area being studied. The magnitude of the data collection effort is greater for larger areas. A study unit's contributing area includes both the area of the study unit itself, as well as the upstream areas which discharge into the study unit. It follows that study units at the lower end of the watershed will have larger contributing areas than those in the upper end of the watershed.

Within the ESCAFCA watershed, there are very limited watershed studies available. The data collection effort within ESCAFCA boundaries will be great especially since access to tribal lands is difficult.

4.3.2 Hydrologic Complexity

Hydrologic complexity is generally a function of the study unit's homogeneity. Analysis of a basin comprised of similar landforms, topography, soils, etc. requires much less effort than that of a basin with a variety of features.

4.3.3 Current State of Development

Development tends to increase the work involved in the analysis of a study unit. Because development tends to alter historical drainage paths, a great deal of research is involved in determining how runoff is conveyed through a developed area. In addition, development tends occur in a "piecemeal" fashion, such that drainage structures serve only the areas benefitted by a particular development, and not necessarily in conjunction with those of previous developments. Therefore a more highly-developed study unit requires more consideration to determine whether each individual development's drainage facilities are operating effectively (or can be altered to do so), and to ensure that future facilities can incorporate existing facilities to fit the overall drainage plan.

4.3.4 Availability of Suitable Outfall

The effort required to find and recommend a physically and politically suitable outfall when none currently exists can be major. The existence of a suitable outfall can, by the same token, significantly reduce the number and scope of recommended upstream alternatives because alternate outfalls are so difficult to obtain.

There are currently only two drainage outfalls to the Rio Grande within ESCAFCA jurisdiction. They are the Arroyo Maria Chavéz and Las Huertas Creek. All other drainage outfalls lie outside of ESCAFCA jurisdiction or are constrained by existing development. The NM 550 corridor could provide outfall opportunity within existing

ROW, however, this is constrained by both capacity and constructability. Suitable discharge to the river along the NM 550 corridor would require capacity for approximately 4,228-cfs of un-attenuated flow from basins contributing to north Bernalillo, and although these flows could be reduced using detention facilities, it is unlikely that the resulting flows could be attenuated enough to use the NM 550 corridor as a suitable option for outfall to the Rio Grande.

4.3.5 Jurisdictional Complexity

Jurisdictional complexity refers to the anticipated difficulty involved in design and construction of improvements within a given area resulting from coordination with multiple government and regulatory agencies. To generate and recommend drainage solutions in areas of mixed jurisdiction with confidence can be difficult. The level of effort required to plan effectively in areas with mixed jurisdiction is directly (and probably geometrically) proportional to the number of agencies involved. A study unit with many different government agencies is likely to require a much more administrative effort than one with a single governmental agency.

4.3.6 Availability of Data

Availability of data refers to the amount of existing analysis resources that can be utilized to assist in completion of future analyses. Study units for which a wealth of data exists can often be assessed without having to duplicate effort in data collection, thus considerably reducing the amount of work involved.

The amount, quality, and age of data available during the master planning effort can have one of several impacts on the level of effort. If the data is comprehensive, well-documented and generally follows the policies and assumptions in use at the time of the master planning, it can reduce the level of effort required considerably. If the data is on the other hand, out-of-date as to policies and assumptions, poorly documented and/or covers only a small percentage of the study unit, its usefulness can vary from almost zero to be detrimental.

The following is a summary of level of effort.

Study Unit Number	Study Unit	Contributing Area	Hydrologic Complexity	State of Development	Outfall Availability	Jurisdiction	Available Data	Totals
1	Algodones	6	1	8	8	8	3	34
2	Bernalillo North	9	2	9	9	9	2	40
3	Bernalillo South	5	3	10	10	10	1	39
4	Arroyo Maria Chavez	4	4	4	3	3	6	24
5	Lower Las Huertas Creek	10	5	5	2	6	5	33
6	Upper Las Huertas Creek	8	10	3	1	2	9	33
7	Arroyo Agua Sarca	3	8	7	5	5	4	32
8	NM 165	1	6	6	6	4	8	31
9	Canon del Agua	2	9	2	7	7	7	34
10	Arroyo de San Francisco	7	7	1	4	1	10	30

Table 4.1: Level of Effort Matrix

Study Unit	Totals
Bernalillo North	40
Bernalillo South	39
Algodones	34
Canon del Agua	34
Lower Las Huertas Creek	33
Upper Las Huertas Creek	33
Arroyo Agua Sarca	32
NM 165	31
Arroyo de San Francisco	30
Arroyo Maria Chavez	24

Table 4.2: Level of Effort Ranking

4.4 Anticipated Changes in Land Use

Detailed study will be required to determine trends in projected future long-term growth. It is recommended that planning and design of future ESCAFCA drainage facilities be based on official Sandoval County population and development projections and guidelines. Hydrologic soil group classifications (i.e., "Land Treatments") for this drainage master plan have been computed based on both existing conditions and anticipated future conditions.

5 Proposed Projects and Improvements

5.1 Legislation of the Watershed

ESCAFCA jurisdiction encompasses several incorporated areas with formal governmental entities. These entities include the Village of Algodones, the Town of Bernalillo, and the Village of Placitas. Unincorporated areas lie within Sandoval County Jurisdiction. Although ESCAFCA adjoins several tribal/pueblo lands, none of these lands lie within ESCAFCA boundaries.

To date, ESCAFCA has not entered into any formal agreements with the several local governments, nor non-governmental agencies within its boundaries. It is recommended that ESCAFCA, at its earliest opportunity, draft a resolution enacting a formal drainage policy. The policy could allow ESCAFCA to set restrictions, via a formal review process, to developments that impact the various arroyos. This in turn, could help to maintain the quality of watersheds. This document should be distributed to all stakeholders within ESCAFCA jurisdiction as well as agencies adjacent to ESCAFCA boundaries, such as Pueblos, BLM, and the forest service.

5.2 Projects

Projects will be concentrated in areas where benefit can be provided to populated areas, namely Algodones, Bernalillo, and Placitas. Due to the magnitude and complexity of drainage problems in the populated areas west of I-25, it is likely that any opportunity to provide relief from drainage problems will require sacrifices. However, intercepting offsite flows prior to entering the populated areas west of I-25 would virtually eliminate the vast majority of serious drainage problems currently experienced by Bernalillo and Algodones residents. It should be emphasized that the following proposed scenarios are preliminary solutions and conceptual in nature. Final recommendations will consider input as well as more detailed study within specific project areas.

5.2.1 Algodones

Drainage problems in Algodones (described in §2.4.1) are due largely to lack of storm water conveyance facilities between I-25 and the Rio Grande. Uncontrolled storm water damages private businesses and residences, roadways, and MRGCD infrastructure. The most efficient solution to these drainage problems is to provide a mechanism of intercepting runoff before it impacts populated areas.

5.2.1.1 Algodones Diversion Channel

Because Algodones exhibits relatively little development along Interstate 25, there is still ample opportunity for ROW and easement acquisition that would allow construction of a large diversion channel. In addition, the only established outfalls to the Rio Grande within ESCAFCA jurisdiction are located in Algodones. Established Algodones Main Canal crossings for both the Arroyo Maria Chavéz and Las Huertas Creek currently exist.

Preliminary investigation indicates that a major diversion channel could be constructed from the southwest quadrant of NM 315/I-25 interchange to Los Romeros Road, thence

west around a small plateau, and ultimately discharging to Las Huertas Creek. Engineered improvements to existing levees and lining of the channel along Las Huertas Creek would be necessary to ensure adequate capacity. Further, a water quality structure would likely be required before discharging to the Rio Grande. A smaller diversion channel could be constructed north of the NM 315/I-25 interchange. (See Exhibit B.2, Appendix B, for illustration of proposed improvements.) As future development proceeds in Algodones, it is anticipated that smaller drainage infrastructure would discharge into the diversion channel. Albuquerque's North Diversion Channel (shown above) is an example of a similar flood control structure. It should be noted that while a major diversion channel is a long-term solution, several other less expensive options would provide immediate flooding relief while working with an ultimate diversion scenario.

5.2.1.2 Algodones Regional Detention Facilities

In order to mitigate drainage problems in the interim, it is recommended that ESCAFCA investigate locations along Interstate 25 to construct regional detention facilities that will provide flood protection for more frequent rainfall events. Two locations that would likely provide considerable benefit are the arroyos immediately east of Los Romeros Road downstream of I-25, and the arroyos discharging to the southeast quadrant of the NM 315/I-25 interchange. Drainage basins upstream of both of the Interstate crossings at these locations have been determined to cause considerable flooding damage during most rainfall events.

Both locations are suitable for considerable land acquisition due to the lack of development, and it is anticipated that outfall from both facilities could be conveyed within storm drain infrastructure. It is possible that the MRGCD ditches and canals could be utilized as outfalls for detention facilities. AMAFCA has several such dam, which would be equipped with gates to prevent surcharge of canals and risers with inverted inlets to provide adequate stormwater quality measures. The photos above illustrate a gated outfall to an MRGCD canal and the ability of detention facilities to improve water quality by trapping floatable debris in stormwater. At the Algodones Main Channel, storm water could be conveyed to the Rio Grande either via

pump station or by constructing a siphon crossing. Exhibit B.2 illustrates proposed projects for the Algodones area.

5.2.2 Bernalillo

Similarly to Algodones, drainage problems in Bernalillo (described in §2.4.2) are due largely to lack of adequate storm water conveyance to the Rio Grande. Uncontrolled storm water damages private businesses and residences, roadways, and MRGCD infrastructure. Likewise, the most efficient solution to these drainage problems is a major diversion that intercepts flows upstream of populated areas. Because of existing development and topography, Bernalillo would likely require at least two major diversions, one north of NM 550 and one south of NM 550.

Because Bernalillo exhibits considerable development both immediately upstream and downstream of Interstate 25, construction of major diversions would be problematic, though not impossible. A more pragmatic solution to drainage problems in Bernalillo would be a series of regional detention facilities working in conjunction with diversion channels. Conceptually, these detention facilities would be constructed either immediately upstream or downstream of I-25 and discharge to a large diameter conduit, ultimately transitioning to an open channel. Preliminary investigation has identified three potential sites for detention and diversion.

5.2.2.1 North Bernalillo Detention Facility

This facility would include a flood control pond east of North Hill Road, immediately south of the American Gypsum plant. This pond would discharge to either a closed conduit or open channel. This channel would parallel the BNSF railway and pass under the existing railroad bridge. From there, flows would be conveyed in an open channel adjacent to Llanito Road and MRGCD's Albuquerque Main Channel. At Ranchitos Road, the open channel would cross the Albuquerque Main Channel and follow Ranchitos Road, ultimately crossing the Albuquerque Wasteway in either a pump station or by constructing a siphon crossing. (See Exhibit B.3, Appendix B, for details of proposed improvements.) It should be noted that all detention facilities would be suitable as multi-use recreational facilities while not detaining stormwater runoff. An example of such a facility is shown in the photo above.

5.2.2.2 Mid-Bernalillo Detention Facility

This facility would consist of a detention facility east of the existing 3-8'x6' box culvert crossing I-25, immediately north of the abandoned Sandia Pueblo aggregate mine. This facility would discharge to an open channel and flow north to the existing 10'x7' box culvert. At this location the channel would intercept discharge from the Piedra Lisa Dam.

The channel would then pass under I-25 in the existing box culvert and continue west in an open channel adjacent to the south side of NM 550. This alternative would require considerable land acquisition, possibly including one with an existing dwelling. The open channel would continue west to the Albuquerque Wasteway where either a pump station or siphon crossing would be constructed.

Alternately, the detention facility could be located immediately downstream of the 3-8'x6' box culvert and discharge to a conduit or open channel paralleling South Hill Road until reaching the alignment described above. (See Exhibit B.3, Appendix B, for details of proposed improvements.)

5.2.2.3 South Bernalillo Detention Facility

This scenario would provide a detention facility east of the existing 3-11'x10' box culvert crossing I-25, immediately south of the abandoned Sandia Pueblo aggregate mine. This facility would discharge to an open channel parallel to I-25, crossing under the interstate near the I-25/Avenida Bernalillo interchange. At this point the channel would continue south along South Hill Road to a location adjacent to the Sandia Acequia. At this point, the open channel would turn west, flowing roughly parallel to the Sandia Acequia until it reaches the Albuquerque Wasteway where either a pump station or siphon crossing would be constructed. (See Exhibit B.3, Appendix B, for details of proposed improvements.)

5.2.3 Placitas

Drainage difficulties affecting Placitas residents (described in §2.4.3) are both more varied and more widespread, such that a "drainage concept" will not alleviate all drainage issues. Therefore, in general, difficulties will be addressed on a case-by-case basis. However, it is anticipated that by enacting effective drainage policy, future drainage problems can be eliminated by preventing development within established FEMA floodplains. To this end, it is recommended that one of ESCAFCA's priorities in the Placitas area be to establish erosion limits of existing major arroyos (i.e., the maximum anticipated extent of erosion within an arroyo). No development would be allowed within the "prudent" lines of the erosion envelope. The prudent line concept is illustrated in Figure 5.1 below.

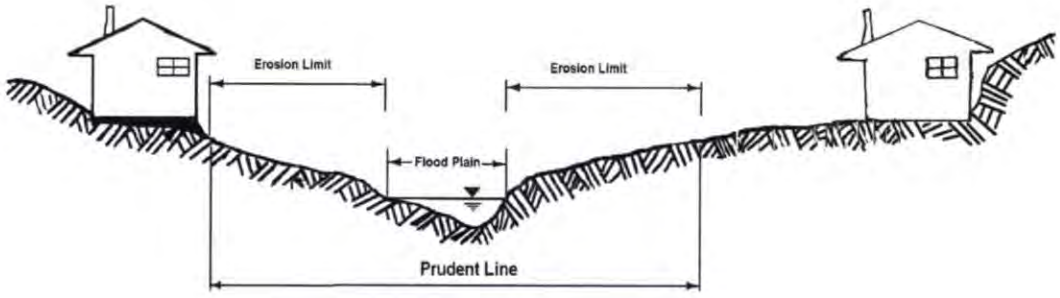

Figure 5.1: Prudent Line Schematic

Of the recurring issues affecting Placitas residents, the issue of erosion and exposed natural gas and petroleum pipelines within arroyos is by far the most serious. As a state

regulatory agency, the Authority is able to provide minimum design standards for pipeline operators, and if necessary, injunctive relief to residents if pipeline operators fail to properly protect their infrastructure from the effects of routine storm water runoff. To protect against erosion of existing pipelines, it is recommended that channel stabilizing structures are constructed within arroyos containing pipeline infrastructure. This is generally accomplished by constructing "hard points" within an arroyo that establish an equilibrium slope that eliminates erosion. These grade stabilization structures can be made with architecturally aesthetic features or buried such that they are either hidden. (See Exhibit B.4, Appendix B, for details of proposed improvements.)

6 Budget and Funding Sources

Initial studies for ESCAFCA have been funded by an initial administrative grant of $150,000 from the Eastern Sandoval County Arroyo Flood Control Authority Act (HB 939), two $50,000 grants from Sandoval County and the Town of Bernalillo, and additional funding and support from Southern Sandoval County Arroyo Flood Control Authority (SSCAFCA). Subsequent funding for construction projects will be collected from a Mill Levy Tax voted upon by constituents of the jurisdiction. This will allow ESCAFCA to issue bonds to pay for future projects on an annual basis. ESCAFCA's financial consultant, RBC Dain Rauscher, is currently analyzing the jurisdiction's bonding capacity. Based on the result of this analysis, projects will be distributed equitably between municipalities, according to need and benefit. As ESCAFCA becomes a more established agency, larger projects could be funded through grants from state and federal sources for specific projects.

7 References

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DRAINAGE MASTER PLAN
AND
NEEDS ASSESSMENT

Appendix A –
Documented Drainage Deficiencies Maps

Exhibit A.1 – Algodones Area Deficiencies
Exhibit A.2 – South Bernalillo Area Deficiencies
Exhibit A.3 – North Bernalillo Area Deficiencies
Exhibit A.4 – Placitas Area Deficiencies

DRAINAGE MASTER PLAN
AND
NEEDS ASSESSMENT

Appendix B –
Watershed Map & Project Implementation Maps

Exhibit B.1 – Overall Drainage Basins
Exhibit B.2 – Algodones & West Placitas Area Improvements
Exhibit B.3 – Bernalillo Area Improvements
Exhibit B.4 – Placitas Area Improvements
Plate 1 – Hydrologic Basin Boundaries

DRAINAGE MASTER PLAN
AND
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Appendix C –
Technical Appendix (Under Separate Cover)

1. Drainage Basin Schematic
2. Existing Conditions Model
3. Future Conditions Model
4. Interstate 25 Crossing Structure Inventory
5. Interstate 25 Crossing Structure Hydraulic Calculations
6. Diversion Channel Hydraulic Calculations